SMART NAS Test Bed Overview

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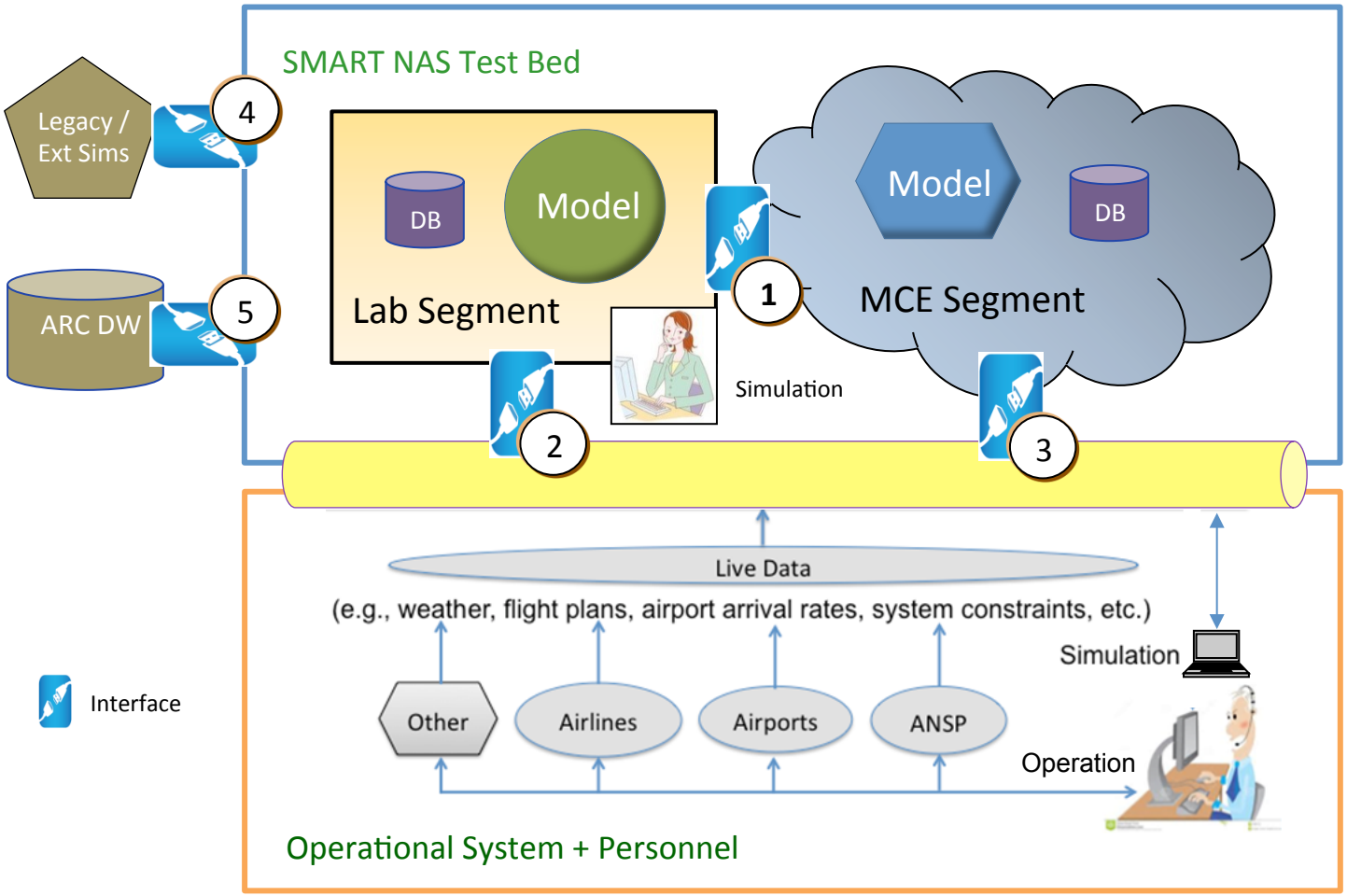
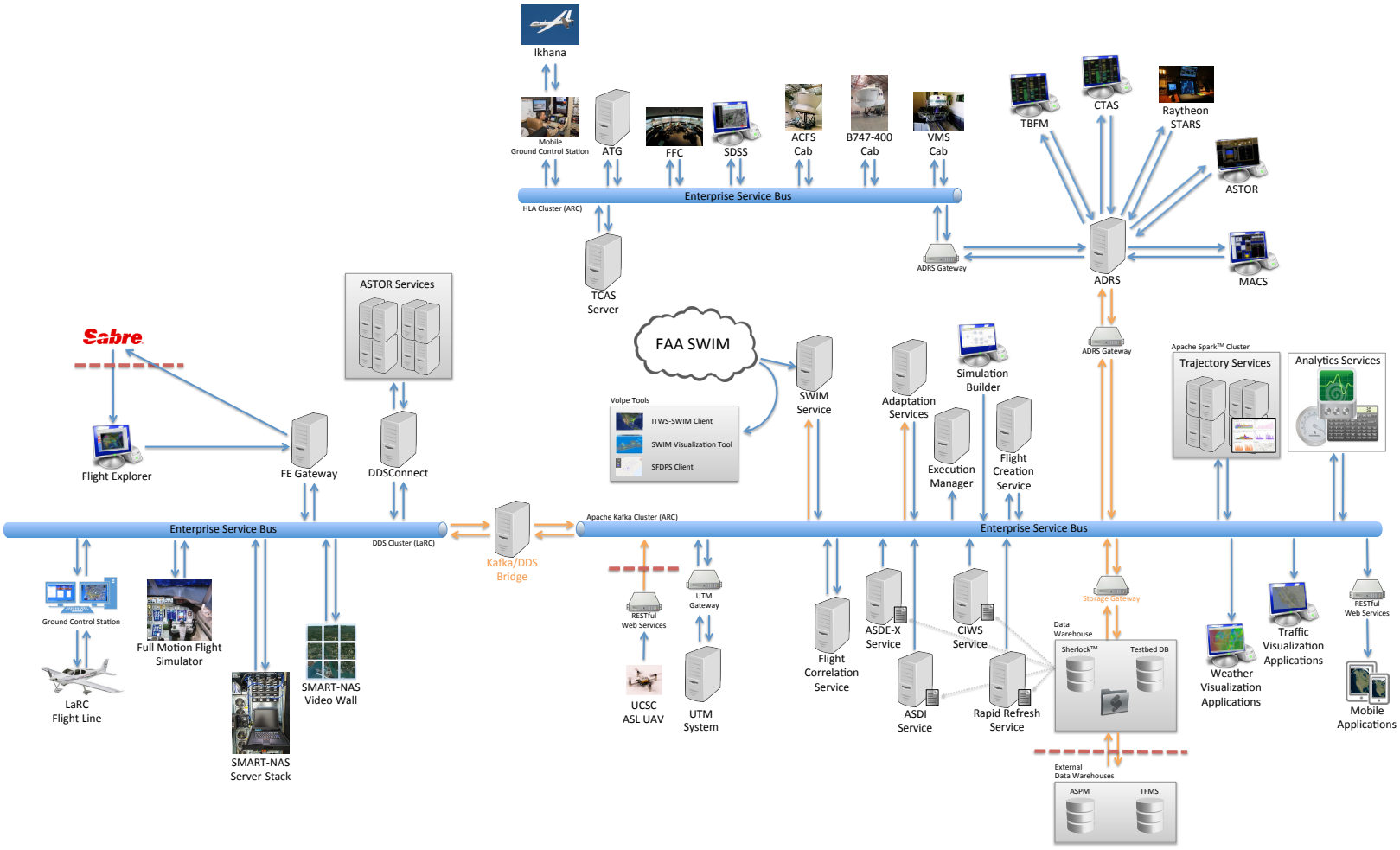
SMART NAS Test Bed and Context



SNTB Year #1 Architecture



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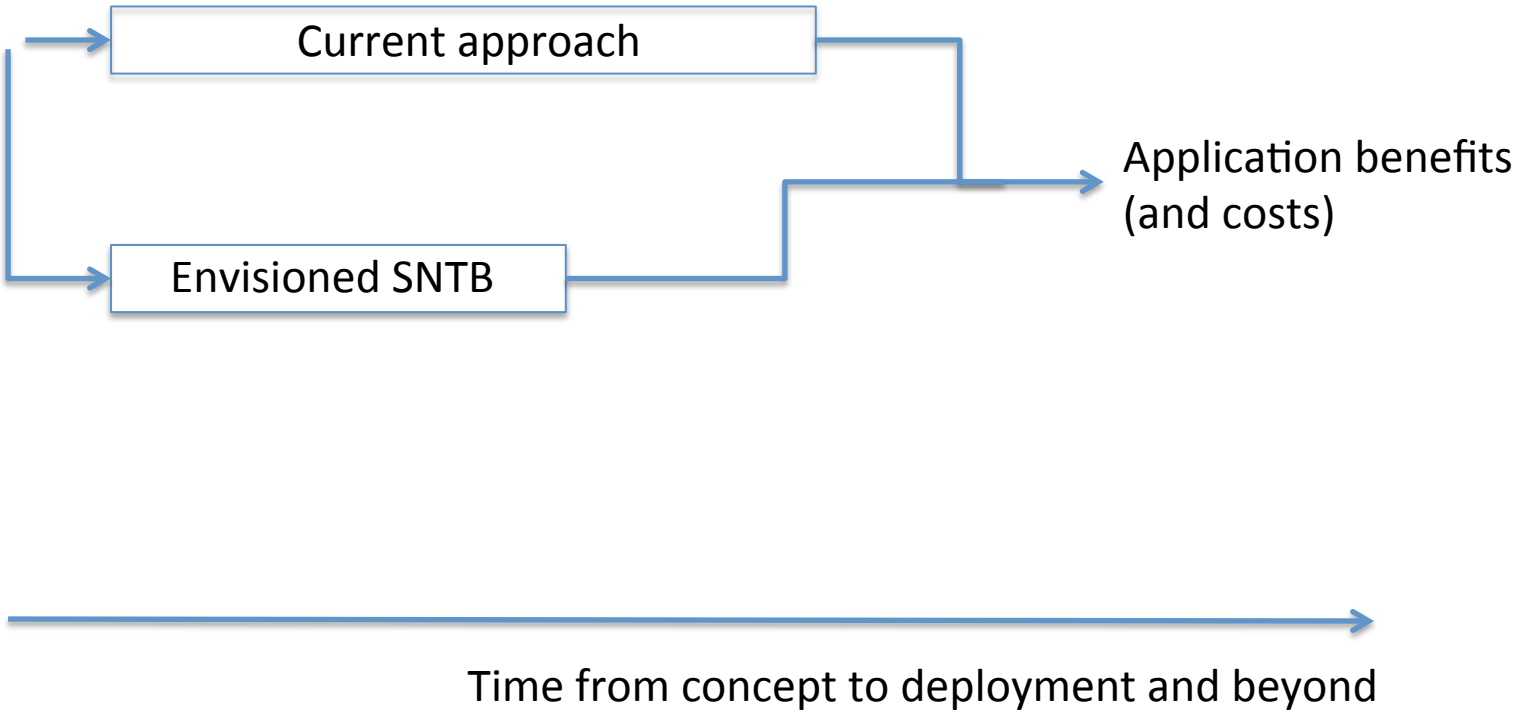
SMART-NAS Test Bed Overview

- SMART NAS Test Bed role
- Metric and Benefits
- Objectives
- Use Cases
  - Trajectory-Based Operations
  - UAS Integration
  - Real-time System-wide Safety Assurance
- Approach
  - Use-case driven
  - Concepts & Technologies development life cycle
- Status

SNTB Role

Trajectory Based Operation Concepts & Technologies



Metric

- Concepts & Technologies measures:
  - Delay/cost reduction
  - Increased throughput
  - On time/predictability/stability, flexible schedule/on demand
  - Maintain or enhance safety and environmental impact
  - Maintain or reduce workload

Accelerated delivery of benefits of Concepts & Technologies

Benefits

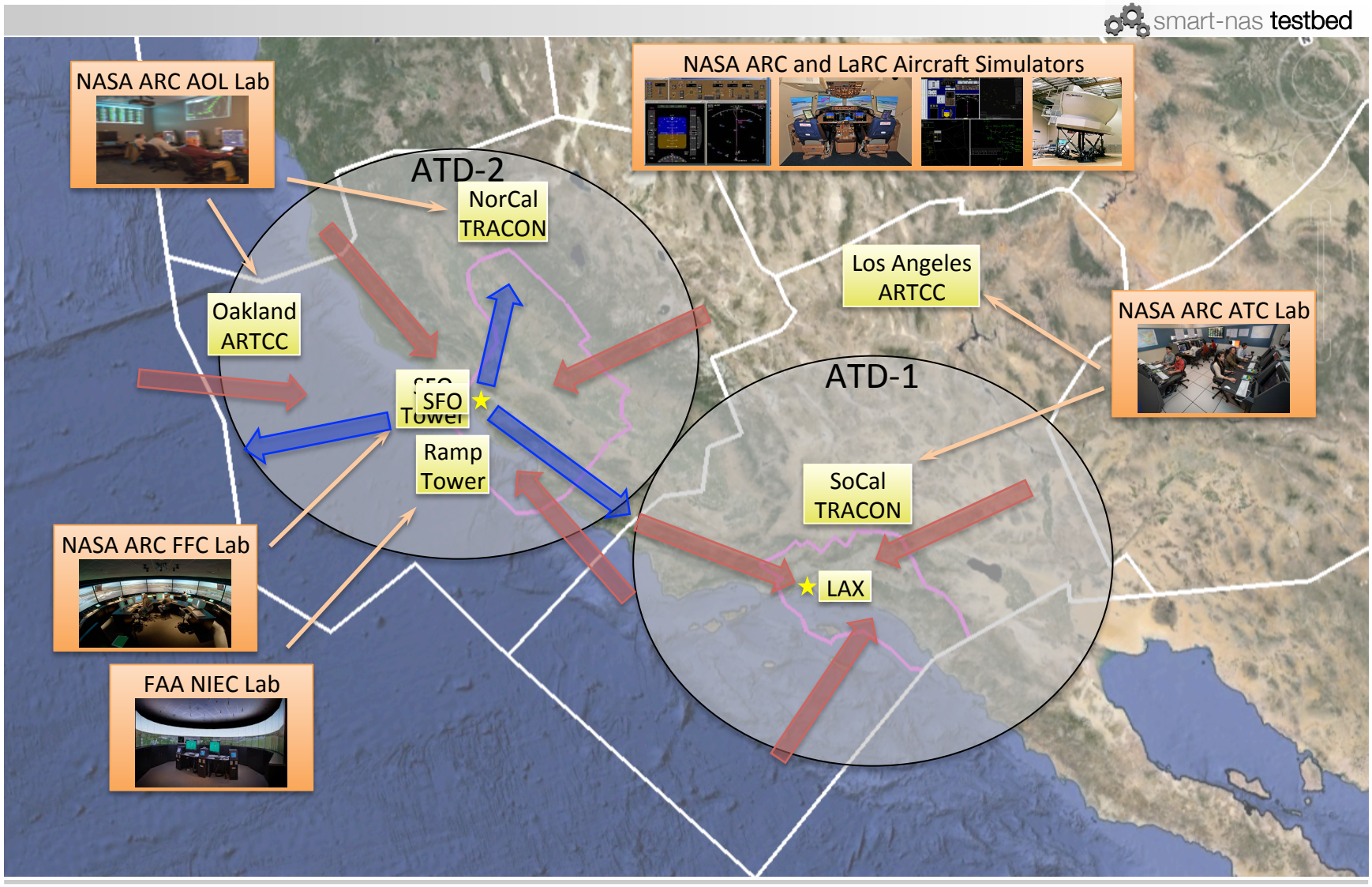
- Higher Complexity and Broader Scope
  - Integrate across ATM domains and beyond physical labs
  - Evaluate more diverse operations
- Higher Fidelity
  - Standardize simulation infrastructure across work-groups
  - Use live, virtual, and high-fidelity constructive assets
- Easier Access to Real-time Simulations
  - Automate human-intensive preparation and post-processing
  - Leverage advances in software assurance and big data

Objectives

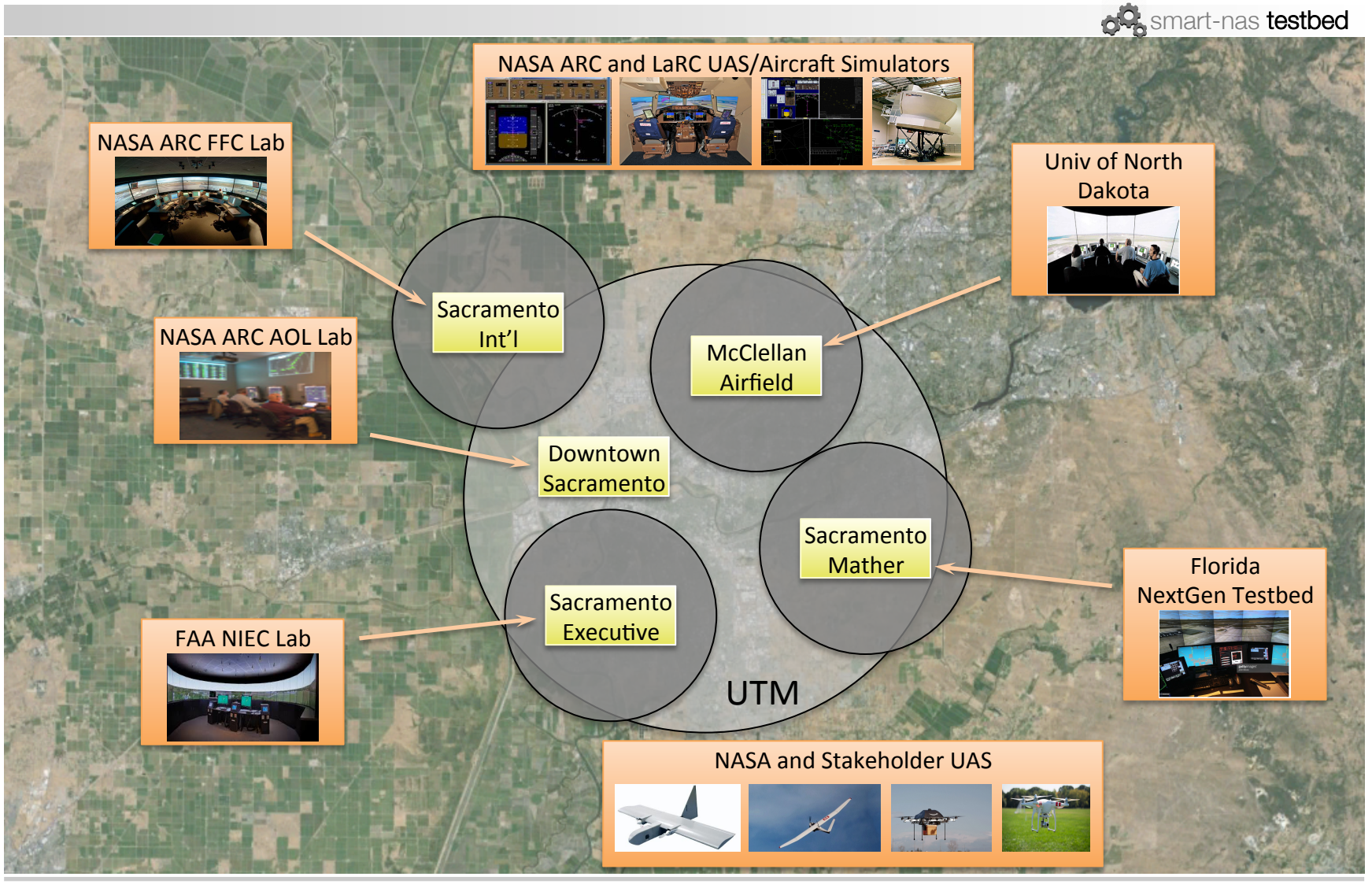
Enable high-fidelity human-in-the-loop and automation-in-the-loop simulations and tests that are either impractical or impossible today but are needed to:

- Validate concepts using multiple operational domains (gate-to-gate TBO)
- Investigate concepts related to revolutionary operations (UAS integration)
- Provide a high-fidelity test environment for real-time system-wide safety assurance (RSSA) capabilities

Arrival/Departure TBO Use Case



Integrated UTM Use Case



Real-time System-wide Safety Assurance

- Current Capabilities
  - Testing uses limited amounts of data
  - Data access is cumbersome and not centralized
  - Safety algorithms separate from real-time human-in-the-loop simulations

- SMART-NAS Test Bed Capabilities
  - Testing uses data from throughout the NAS
  - Data access is via standardized interfaces
  - Safety modeling algorithms integrated with simulation infrastructure

Concepts & Technologies Development Life Cycle

- Research and Exploration
- Architecture and Design
- Product Development
- Product Testing
- Product Deployment
- Product Support
- Maintenance & Migration

Use Cases (Year 1 and Year 2)

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2016

- **UC-1: Scenario Validation**
  - User Management and GUI Front End
  - Fixed Component Library
  - Simulation Architect
  - Big Data Driven Scenario Builder
  - Execution Manager
  - DDS Message Bus
  - WorldWind Visualization
- **UC-5: Phase 1 TBO Simulation (Metroplex)**
  - Integrated Industry and NASA Simulation
  - Metroplex arrival and departure scheduling integration
  - JFK OPD arrival and 4 runway operations
  - Large scale simulation with low and medium fidelity components
  - High Fidelity Visualization
- **UC-8: Data Analytics**
  - UTM Connectivity
  - Real-time System-Wide Safety Connectivity
  - SWIM/Legacy Data Streaming
  - Data Warehouse Data Streaming
  - Static Resource Allocation

2017

- **UC-5: Phase 1 TBO Simulation (ATD-1)**
  - Participant VoiceComm
  - Distributed Environments (NASA)
  - En Route and Terminal Platforms
  - Metrics Dashboard
- **UC-2a: Autonomy Simulation**
  - Open Component Library
  - Give-Take Scenario Builder
  - Participant DataComm
  - Dynamic Resource Allocation
  - Cloud Support
  - Limited Scaled Real-time Support

Use Cases (Year 3 and Year 4)

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2018

- UC-2a: Autonomy Simulation
  - Extensive Scaled Real-time Support
- UC2b: UAS Simulation (UTM)
  - Out-the-Window Visualization (Tower)
  - Out-the-Window Visualization (Aircraft)
  - Airport Tower Platforms
  - Ground Control Stations
- UC4: Phase 2 TBO Simulation (ATD-2)
  - Distributed Environments (External)
  - Airline Ramp Tower Platforms

2019

- UC3: Phase 3 TBO Simulation (ATD-3)
  - Secure Component Library
  - Convective Weather Integration
  - Oceanic Platforms
  - Airline Operations Center Platforms

Status

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- Finished 2-Year Testbed Architecture NRAs
  - Defined enterprise service bus architecture for distributed high-fidelity simulations
  - Cost/benefit assessments showed positive benefits for both research activities and deployment of new ATM systems
- Developed Proof-of-Concept Testbed Software
  - Focused on traffic, weather, and airspace data integration
  - Investigated several software assurance, cloud-computing, big data, and real-time analytics technologies relevant to implementation
- Implementing Full-scale Testbed Software
  - Realistic scenario design and validation for gate-to-gate TBO simulations
  - Scalable and distributed data provider for real-time data analytics

SMART NAS Test Bed Highlight

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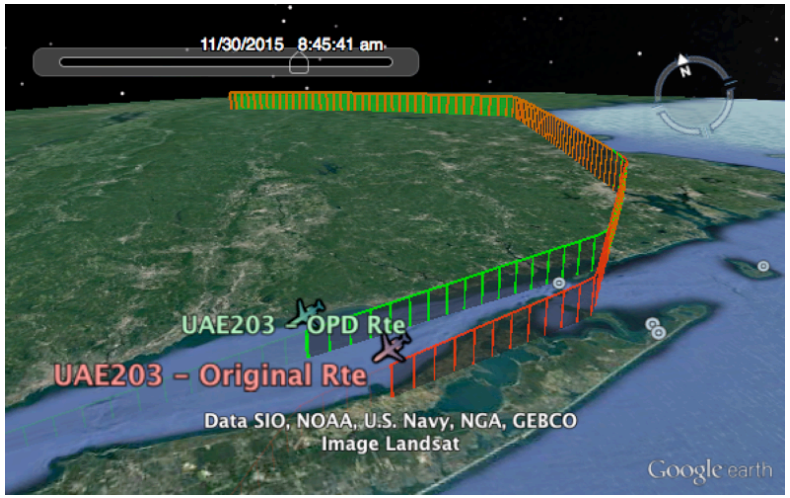
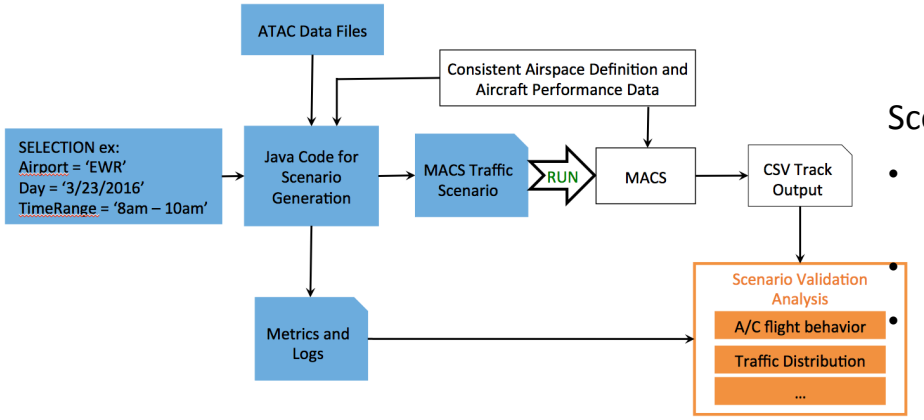
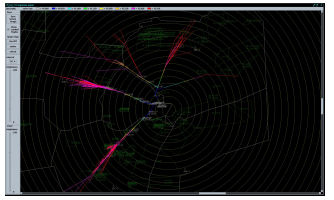




Early exploration enabling metroplex-type simulation of NY-area airports. As part of NY TBO project and working with PANYNJ

- In July 2016, NY metroplex with combined arrival, departure, and surface operations was simulated using early SNTB execution and connection framework for distributed simulation
- Preliminary SNTB enabled metroplex scenario simulation



Scenario Validation (Use Case #2)

- Initial auto-generation of MACS scenario input file from data in database (minutes to generate)
- Manually verify on MACS and keep statistics
- Next: automating the verification step